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ORIGINAL ARTICLE

Impact of physical activity levels and diet on central obesity among civil servants in Tamale metropolis

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This study sought to assess the prevalence of central obesity using Waist to Hip ratio as well as establishing the relationship between physical activity, diet and central obesity among civil servants in the Tamale metropolis. This cross-sectional study was conducted between January and July, 2011. One hundred and eighty six (186) subjects were involved with 121 being males and 65 being females. The study participants were recruited from an adult population between the ages of 20 -59 years. Dietary pattern was assessed using food frequency questionnaires whilst physical activity was determined using the WHO Global physical activity levels questionnaire. The prevalence of central obesity was found to be 31.2%. The prevalence of central obesity was significantly higher (p=0.031) among females (41.5%) compared to men (25.6%) and also increased with age (p<0.0001). The prevalence of obesity significantly decreased (p = 0.018) from 70.7% via 25.6% to 3.4% as the level of physical activity increased from low through moderate to high. There were no significant associations between dietary pattern and central obesity from this study. Central obesity from this study is high and more common in females. The level of physical activity appears to be a key determinant of the prevalence of central obesity in this study. Preventive actions such as exercise and active lifestyles have to be implemented to reduce the tendency for central obesity in this population in particular and the general Ghanaian populace at large.
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INTRODUCTION

There is a worldwide obesity epidemic with the prevalence of overweight and obesity exceeding 50% in almost all the regions of the world (Balkau *et al.*, 2007). Over the past three decades, this epidemic has affected the industrialized countries, with some areas of North America, Europe and Asia having more than threefold increase in the prevalence of obesity (Fezeu *et al.*, 2008; Parikh *et al.*, 2007; Wang *et al.*, 2007). In recent times, low- and medium-income countries have joined the obesity epidemic, and the increase has been faster in these countries (Fezeu *et al.*, 2008; Wang *et al.*, 2007).

Genetics and lifestyle changes such as diet and physical activity level can greatly modify the prevalence and severity of obesity in adults (Helge, 2002). In a healthy adult population, there is an inverse relationship between the level of physical activity and obesity (Ford *et al.*, 2002; Katzmarzyk *et al.*, 2004; Owiredu *et al.*, 2011). The causes and prevalence of obesity vary from population to population based on individual life style, diet, cultural background, genetic make-up as well as the type of instrument used in the assessment of obesity.

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The prevalence of obesity was found to be 5.5% in Ghana and higher among women (7.4%) compared to men (2.8%) using body mass index (Biritwum *et al.*, 2005). In a study conducted by Owiredu *et al.,* (2011) in Kumasi, the prevalence of obesity was found to be higher among sedentary workers (17.4%) compared to active subjects (5.9%) using body mass index. On the other hand, using waist to hip ratio, the prevalence of central obesity was found to be 27.9% among sedentary workers as compared to 2.9% in active subjects (Owiredu *et al.*, 2011). In Ghana there is paucity of data on the prevalence of central obesity among civil servants. However, with the increasing westernization of Ghanaian lifestyle and eating habits the prevalence of obesity has been reported to be on the increase across the country. This study therefore sought to find the prevalence of central obesity among civil servants in the Tamale Metropolis as well as the impact of diet and physical activity level.

MATERIALS AND METHODS

Subjects

This cross-sectional study was conducted between January and July, 2011. The subjects comprised of 186 adult civil servants in the Tamale Metropolis in the Northern Region of Ghana. All personnel from the 13 civil service departments in the Tamale Metropolis were eligible to participate in the study. The subjects were selected using a proportionate random sample that included more subjects from larger departments with the use of a random numbers statistical table. The participation of the subjects was voluntary and informed consent was obtained from each subject. Subjects who were on medication known to modify serum lipid or carbohydrate metabolism were excluded from the study. The study was approved by the Ethics Committee of the University for Development Studies, School of Medicine and Health Sciences, Ghana.

Anthropometric variables

Anthropometric measurements included waist circumference, measured midway between the inferior angle of the ribs and the suprailiac crest. Hip circumference, measured as the maximal circumference over the buttocks in centimetres. Both measurements were measured to the nearest 1 cm using a non-stretchable fibre-glass measuring tape (Butterfly, China). During both measurements, subjects were made to stand upright, with arms relaxed at the side, feet evenly spread apart and body weight evenly distributed in accordance with the WHO expert consultation report on waist circumference and waist-hip ratio (WHO, 2004). Waist to Hip Ratio (WHR) was calculated by dividing the waist circumference (cm) by the hip circumference (cm). Men with WHR < 0.90, 0.90–0.99 and ≥ 1.0 were classified as normal, overweight or obese respectively, while women were classified in the same categories on the basis of WHR of < 0.80, 0.80 – 0.84 and ≥ 0.85 (WHO, 2004).

Physical activity level

The level of physical activity was assessed using the Global Physical Activity Questionnaire (GPAQ) (WHO, 2009). The GPAQ comprised of 19 questions about physical activity level in a typical week. The frequency and duration of time spent doing physical activity is measured in 3 domains: activity at work, travel to and from places and recreational activities.

The GPAQ was selected as a result of its standardization, easiness to administer, relative unobtrusiveness and inexpensiveness. Its reliability has been found to be 0.67–0.81 and the validity was 0.54 (Armstrong *et al.*, 2006). The questionnaire was fully adapted for the study, without any modifications. However, to suit the Ghanaian context, local examples of types and intensity of activities were used. The collection of all data and processing followed the GPAQ analysis protocol (WHO, 2009). All durations were converted into minutes. Energy expenditure, measured in MET (Metabolic equivalents), was estimated using duration, intensity and frequency of physical activities performed within 7-days. MET, is the ratio of specific physical activity metabolic rates to the resting metabolic rate (1 MET = the energy cost of sitting quietly, and was equivalent to a caloric consumption of 1 kcal/kg/hour). A MET-minute showed the total activity volume on weekly basis, and calculated by multiplying time spent on each activity during a week by the

MET-values of each level of activity. Using the compendium of physical activities (Ainsworth *et al*., 2000), MET-values for various levels of activities was established. MET values of 4 and 8 were set for moderate-intensity (transport-related walking or cycling) and vigorous-intensity physical activity, respectively. Total MET/minutes/week was computed by the sum of all moderate- to vigorous-intensity physical activities performed at work, transport and recreation. Based on the total met/minutes/week, subjects were classified into low, moderate, and high physical activity levels as defined by the GPAQ analysis framework (WHO, 2009).

High: A subject found within any of the following categories: Vigorous-intensity activity on at least three days achieving at least 1,500 MET-minutes/week OR seven or more days of any combination of walking, moderate or vigorous intensity activities achieving at least 3,000 MET-minutes per week.

Moderate: A subject not achieving the criteria for the high category but either of the following three criteria: (a) 3 or more days of vigorous-intensity of at least 20 minutes per day OR (b) 5 or more days of moderate-intensity and/ or walking of at least 30 minutes per day OR (c) 5 or more days of any combination of walking, moderate-or vigorous- intensity activities accumulating at least 600 MET minutes/week.

Low: Subject's reported activity is lower than the categories outlined above or no activity is reported at all.

Dietary intake

A validated FFQ was used for assessing usual dietary intakes (Ovaskainen *et al*., 2006; Rolls *et al*., 2006). The FFQ was adapted and modified from the Willett food frequency questionnaire in which 38 food items were listed (Willett *et al*., 1987). FFQs have been shown to be valuable tools for evaluating long-term dietary intake, especially in the context of epidemiological studies such as this (Baer *et al*., 2005). The questionnaire considered the number of times subjects ate some listed food items. The listed food items were put into six food groups: carbohydrates (e.g. rice, tuo zaafi (T.Z), etc), proteins (animal source: meat, beans, fish, and plant source: beans, nuts, etc), fats and oils (vegetable oil, palm oil, etc), fruits and vegetables (pineapple, mango, etc), non-alcoholic beverages (soft drinks, etc) and alcoholic drinks (beer, whisky, wine, etc).

Statistical Analysis

The results are expressed as proportion and compared using Fischer's exact test or χ^2 for trend analysis as appropriate. A level of $p<0.05$ was considered as statistically significant. GraphPad Prism version 5.00 (GraphPad software, San DiegoCalifornia USA, www.graphpad.com) for windows was used for statistical analysis.

RESULTS

The general characteristics of the studied population are as shown in Table 1. Majority of the studied population were within 20 to 39 years i.e. 150/186 (80.6%) and have attained a high level of education (89.8%). Even though, male participants represent 65.1% of the studied population, there is no significant difference in the age distribution and educational level between the male and female subjects (Table 1). From this study, the prevalence of obesity and overweight as determined by WHR was 31.2% and 12.4% respectively. When the study population was stratified based on gender, 64.5% of the male subjects significantly ($p = 0.0004$) had normal body weight compared to female subjects (41.5%). However, the prevalence of obesity was significantly ($p = 0.0312$) higher among the female participants (41.5%) compared to males (25.6%) (Table 1).

Whereas about 10% of the studied population was engaged in high level of physical activity, about 30% were engaged in moderate level of physical activity and about 60% were engaged in low level of physical activity as shown in Table 1. There was no significant difference in the levels of physical activity when the studied population was classified by gender. About 27%, 44%, 10% and 5% of the studied population consumed at least one form of carbohydrate rich foods, protein rich foods of animal source, protein rich foods of plant source as well as fats and oils rich foods respectively for more than once a day. Gender had no significant impact on the type of food groups consumed by the studied population (Table 1).

Table 1: General characteristic of the study population stratified by gender

Variable	Total (n=186)	Male (n=121)	Female (n=65)	P value
Age				
20-29	73(39.2%)	43(35.5%)	30(46.2%)	0.161
30-39	77(41.4%)	51(42.1%)	26(40.0%)	0.876
40-49	17(9.1%)	13(10.7%)	4(6.2%)	0.425
50-59	19(10.2%)	14(11.6%)	5(7.7%)	0.458
Educational level				
High	167(89.8%)	108(89.1%)	59(90.8%)	0.805
Central adiposity				
Normal	105(56.4%)	78(64.5%)	27(41.5%)	0.001
Overweight	23(12.4%)	11(9.1%)	12(8.5%)	0.099
Obese	58(31.2%)	31(25.6%)	27(41.5%)	0.031
Physical activity level				
Low	106(57.0%)	68(56.2%)	38(58.5%)	0.876
Moderate	60(32.3%)	39(32.2%)	21(32.3%)	1.000
High	20(10.8%)	14(7.5%)	6(9.5%)	0.805
Diet frequency				
Carbohydrate-rich foods	50(26.9%)	34(28.1%)	16(24.6%)	0.729
Animal protein	82(44.1%)	54(44.6%)	28(43.1%)	0.839
Plant protein	18(9.7%)	11(9.1%)	7(10.8%)	0.712
Fats & Oils	9(4.8%)	5(4.1%)	4(6.2%)	0.540
Fruits & vegetables	29(15.6%)	17(14.0%)	12(18.5%)	0.429
Alcoholic beverages	4(2.2%)	4(3.3%)	0(0.0%)	0.138
Non-Alcoholic beverages	26(14.0%)	15(12.4%)	11(16.9%)	0.396

Data are presented as proportion and analyzed using Fischer's exact test.

From Table 2, using chi-square for trend analysis, there is no significant association between central obesity as determined by WHR and food groups consumed by the studied population using chi square for trend analysis. In Table 3, the type of food groups consumed was stratified based on age. The proportion of the studied population that consumed at least one form of carbohydrate rich food, protein rich food of animal source, fats and oils rich food as well as those that consumed fruits and vegetables for more than once a day generally decreased with age (Table 3).

Table 2: Diet frequency and central adiposity

Variable	Normal (n=105)	Overweight (n=23)	Obese (n=58)	P value
Carbohydrate-rich foods	32(30.5%)	4(17.4%)	14(24.1%)	0.324
Animal protein	46(43.8%)	7(30.4%)	29(50.0%)	0.542
Plant protein	12(11.4%)	0(0.0%)	6(10.3%)	0.689
Fats & Oils	6(5.7%)	0(0.0%)	3(5.2%)	0.783
Fruits & vegetables	16(15.2%)	3(13.0%)	10(17.2%)	0.765
Alcoholic beverages	2(1.9%)	0(0.0%)	2(3.4%)	0.570
Non-Alcoholic beverages	15(14.3%)	4(17.4%)	7(12.1%)	0.737

Table 3: The rate of consumption of the various diet group stratified by age

Variable	20-29 (n=73)	30-39 (n=77)	40-49 (n=17)	50-59 (n=19)	P value
Carbohydrate-rich	26(35.6%)	21(27.3%)	2(11.8%)	1(5.3%)	0.002
Animal protein	44(60.3%)	31(40.3%)	3(17.6%)	4(21.1%)	0.001
Plant protein	7(9.6%)	8(10.4%)	1(5.9%)	2(10.5%)	0.945
Fats & Oils	7(9.6%)	2(2.6%)	0(0.0%)	0(0.0%)	0.025
Fruits & vegetables	17(23.3%)	10(13.0%)	1(5.9%)	1(5.3%)	0.016
Alcoholic beverages	2(2.7%)	2(2.6%)	0(0.0%)	0(0.0%)	0.385
Non-alcoholic beverages	13(17.8%)	9(11.7%)	2(11.8%)	2(10.5%)	0.313

Data was presented as proportion and analyzed using chi-square for trend

The association between age and physical activity level with body weight is presented in figure 1. From the chi-square for trend analysis, the prevalence of obesity significantly increased with age ($p < 0.001$) but decreased with level of physical activity ($p = 0.018$).

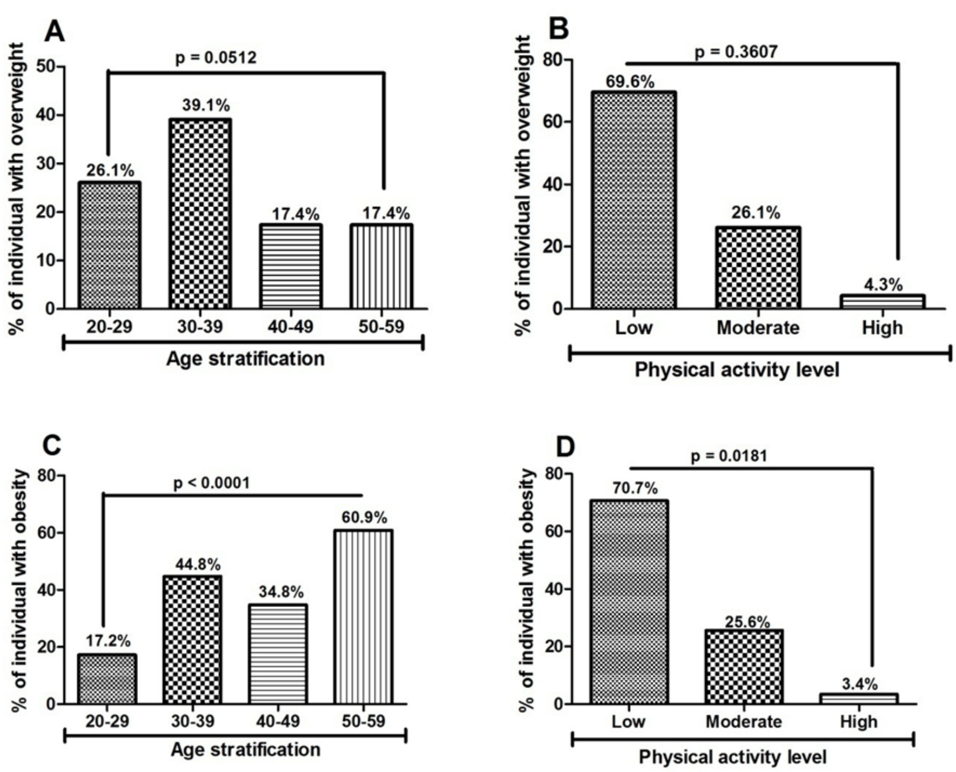

Figure 1: Association between age and overweight (**A**), physical activity level and overweight (**B**), age and obesity (**C**) as well as physical activity level and obesity (**D**). Data was analyzed using chi-square for trend.

DISCUSSION

From the study, the overall prevalence of central obesity was found to be 31.2%. This is consistent with a central obesity prevalence of 31.9% reported in a study among an industrial population in India (Reddy *et al.*, 2006). The prevalence of central obesity in this study was higher than the 20% reported by Addo *et al.,* (2009) among civil servants in Accra and the 14.4% (defined by WHR) reported by Owiredu *et al.,* (2011) in Kumasi. Addo *et al.,* (2009) used Body Mass Index (BMI) to define obesity and this could have accounted for the difference in prevalence. Ferland *et al.,* (1989) reported that WHR was a good predictor of intra-abdominal adipose tissue than BMI. Furthermore, BMI does not account for the wide variation in body fat distribution and has considerable limitations in predicting intra-abdominal fat accumulation (Chen *et al.*, 2000). BMI is therefore not able to differentiate between subcutaneous from visceral fat accumulation (Fujimoto *et al.*, 1999). On the other hand, WHR provides an index of both subcutaneous and intra-abdominal adipose tissue (Bjorntorp, 1987), making the central obesity rates defined by it being higher than rates measured by BMI. Owiredu *et al.,* (2011) conducted their study among active sportsmen/sportswomen and sedentary workers and this could have contributed to the lower prevalence of central obesity. The subjects in that study included active sportsmen and women, who were generally physically active. Subjects in this research however had lower levels of physical activity demonstrated by the inverse relationship between the level of physical activity and central obesity observed in this study.

Central obesity was significantly higher in women than men and this significant finding is in agreement with several studies done elsewhere in Ghana (Hill *et al.*, 2007) and in other African countries (Maher *et al.*, 2011; Shayo *et al.*, 2011; Wahab *et al.*, 2011). Participation in regular physical activity was generally low in this study and was even lower among females. This fact, coupled with the general perception among African women that being obese is a sign of affluence perhaps accounts for such a high obesity prevalence rate among women involved in this study. In a study by Ojofeitimi and colleagues in south western Nigeria, subjects in a University community believed that being obese is a sign of well-being and gives respect (Ojofeitimi *et al.*, 2007).

Generally, obesity increased significantly with increase in age category in this study. These findings are in consonance with prevalence of central obesity found among senior civil servants in Nigeria (Odenigbo *et al.*, 2008), South-African adults in South Africa (Puoane *et al.*, 2002) and Cuban adults in Cuba (Diaz *et al.*, 2009). The proportion of fat deposited in the abdomen increases as body shape becomes more android with age, due to decreasing height and increasing slackness of abdominal wall muscles. During adulthood, weight gain occurs in the abdominal region, emphasizing the importance of hypertrophic obesity, which is generally android (Kaye *et al.*, 1990). This change in the adult figure may influence the positive association between age and excess abdominal adiposity, measured by waist-to-hip ratio (Lanska *et al.*, 1985). This fact possibly explains the increase in obesity prevalence with increasing age category in this study.

In a study on the association of body fat distribution with lifestyle and reproductive factors in post-menopausal women, Kaye *et al.,* (1990) showed that waist-to-hip ratio was negatively associated with physical activity. In addition, a study of subjects from two urban and one rural community in Accra, Ghana, found high levels of overweight and obesity among subjects who were sedentary and engaged in light activity (Amoah, 2003). These findings are consistent with the findings of this current study which showed that subjects with low physical activity levels had significantly high prevalence of overweight (69.6%) and central obesity (70.7%) and the prevalence of both overweight and obesity decreased with increase in the level of physical activity. Similarly, a population based cross-sectional study conducted by Al-Nozha and colleagues among Saudis aged 30-70 years, reported that inactive males and females had a significantly higher waist circumference than active participants of both sexes (Al-Nozha *et al.*, 2007). In a study, in which CT scan was used to assess abdominal obesity, physical activity was shown to be strongly associated with lower visceral adipose tissue in men from 30-70 years (Hunter *et al.*, 1997). One can therefore not overemphasize the well-established protective role of physical activity for the development of obesity and associated co-morbidities. The role of physical activity in the prevention and management of overweight and obesity is linked, in part, to the impact of physical activity on energy expenditure, body composition, and substrate oxidation and metabolism (Donnelly *et al.*, 2004). Policies that would help individuals build a positive attitude towards exercise should be instituted so as to cultivate the habit of engaging in regular and beneficial physical exercises.

There was no significant association between dietary intake and obesity. As indicated in the results of this study, subjects consumed less of both high energy dense foods and fruits and vegetables. This suggests that the high prevalence rate of central obesity found in this research cannot be attributed to dietary intake, but could be due to low levels of physical activity and age. In contrast to the works of other researchers, no relationship was found between alcohol and obesity in this study (Breslow *et al.*, 2005; Colditz *et al.*, 1991; Schroder *et al.*, 2007; Wannamethee *et al.*, 2003). The lack of association could be explained by the small proportion of study participants who indulged in alcohol drinking. The small proportion of alcohol drinkers could be due to the fact that a greater majority of the inhabitants in the Tamale metropolis are moslems (Ghana Government Official Portal, 2012) and as required by the Islamic faith, do not consume alcoholic beverages of any kind.

CONCLUSION

Prevalence of central obesity is high in this study. In consonance with most studies, female subjects were more at risk compared to their male counterparts. Level of physical activity and age category were major determinants of central obesity. Individuals should be encouraged to engage in regular physical exercise.

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